COMPRESSION TEST OF C-SECTION COLD-FORMED STEEL WITH AN OPENING

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Bahagian tunggal adalah pilihan pertama sebelum bahagian berkembar digunakan untuk menahan beban yang disebabkan oleh struktur seperti contohnya bumbung. Kewujudan lubang dalam anggota struktur boleh memberi manfaat kepada kerja-kerja mekanikal dan elektrik, selain itu, secara teorinya kekuatan muktamad struktur akan berkurang disebabkan kewujudan bukaan. Tesis ini membentangkan huraian terperinci mengenai kajian eksperimen kekuatan gelangsar lentur dengan adanya pembukaan tiang keluli terbentuk sejuk. Sebanyak 8 tiang pendek, setiap panjang 600 mm, berbeza mengikut saiz (203 mm dan 103 mm) dan ketebalan (1.3 mm dan 2.0 mm). Ujian mampatan dilakukan dengan menggunakan Mesin Ujian Universal dan kekuatan muktamad diperhatikan. Keputusan ujian 4 spesimen dengan pembukaan dibandingkan dengan yang tidak ada pembukaan. Hasilnya dibentangkan dalam tiga bahagian yang merupakan beban anjakan menegak, beban anjakan melintang dan tingkah laku.

ABSTRACT

Single sections are the first choice before built-up sections used to resist load induced in a structure for example roof trusses. An existence of perforation in the structural member can be benefit to mechanical and electrical works, aside from that, theoretically the ultimate strength of the structure will be reduce due to existence of openings. This paper presents a detailed description of an experimental study of the flexural buckling strength in the presence of a perforation of cold-formed steel column. A total of 8 short columns, each length 600 mm, vary in size (203 mm and 103 mm) and thickness (1.3 mm and 2.0 mm). Compression test were done by using Universal Testing Machine and the ultimate strength were observed. The test result of 4 specimens with an opening were compared to the ones without opening. The result is presented in three section which are load vs vertical displacement, load vs horizontal displacement and buckling behaviour.

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LIST OF ABBREVIATIONS

BS	British Standard
CFS	Cold-Formed Steel
AISI	American Iron and Steel Institute
AISC	American Institute of Steel Construction (AISC)
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
SC	Single C-Section
FE	Finite Element
LRFD	Load and Resistance Factor Design
NH	No Hole
H	Hole

CHAPTER 1

INTRODUCTION

1.1 Introduction

In building construction there are basically two types of structural steel: hot-rolled steel shapes and cold-formed steel shapes. The hot rolled steel shapes are formed at elevated temperatures while the cold-formed steel shapes are formed at room temperature. Cold-formed steel structural members are shapes commonly manufactured from steel plate, sheet metal or strip material. The manufacturing process involves forming the material by either press-braking or cold roll forming to achieve the desired shape(Stone and LaBoube, 2017).

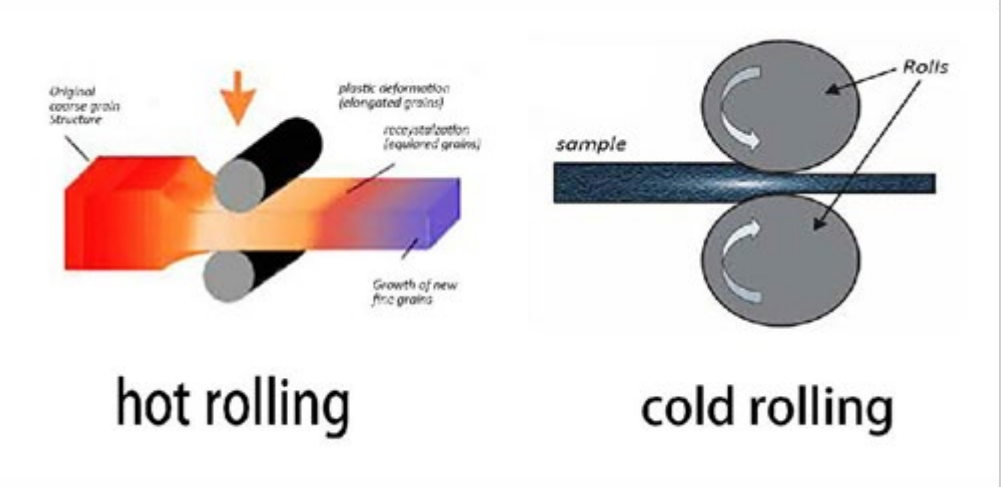

Figure 1. 1: Difference between hot rolled steel and cold formed steel
Source: (What is the Difference between Hot Rolled Steel and Cold Rolled Steel, 2019)

When steel is formed by press-braking or cold rolled forming, there is a change in the mechanical properties of the material by virtue of the cold working of the metal(Liu, Igusa and Schafer, 2010; Gilbert, Teh and Gilbert, 2012). When a steel section is cold-formed from flat sheet or strip the yield strength, and to a lesser extent the ultimate

strength, are increased as a result of this cold working, particularly in the bends of the section.

Cold-formed thin-walled members are used in building industry in many fields. The probably largest area of use is in conventional – mainly industrial – steel structures as secondary and tertiary load-bearing elements – purlins, sheeting – on a steel or reinforced concrete primary structure. Cold-formed members are extensively used in North-America and Australia/New Zealand in residential housing as primary load-bearing structures; light-gauge building systems are gaining on popularity and compete with the traditional building material, wood(Fratamico *et al.*, 2018). There are several examples of multi-storey office buildings with a primary load-bearing system consisting entirely of cold-formed members as well. Another large area of use is composite slabs, where trapezoidal sheeting and cold-formed sections are used as tension and a thin concrete slab as compression parts resulting in light floor systems applicable in buildings made of cold-formed members or in refurbishment. Cold-formed members are also extensively used in warehouse racks.

Figure 1. 2: One of the usage of cold-formed steel
Source:(Dinis *et al.*, 2012)

Cold-formed steel often produced with opening specifically for fasteners like bolts, screws, rivets, etc. and such openings may be neglected as they are filled with material(de Barros Chodraui *et al.*, 2009) (Figure 1.2). However, any other openings should be taken into account. The ultimate strength and elastic stiffness of a structural member can be vary due to opening, size and shape in this case reduction of surface area(Georgieva *et al.*, 2012). Openings need to be considered in evaluation of the section properties of members in compression. The perforations can be classified into two; pre-punched and punched-on-site but mostly pre-punched are more favourable due to the problem that will rise later if the holes are not accurately made.

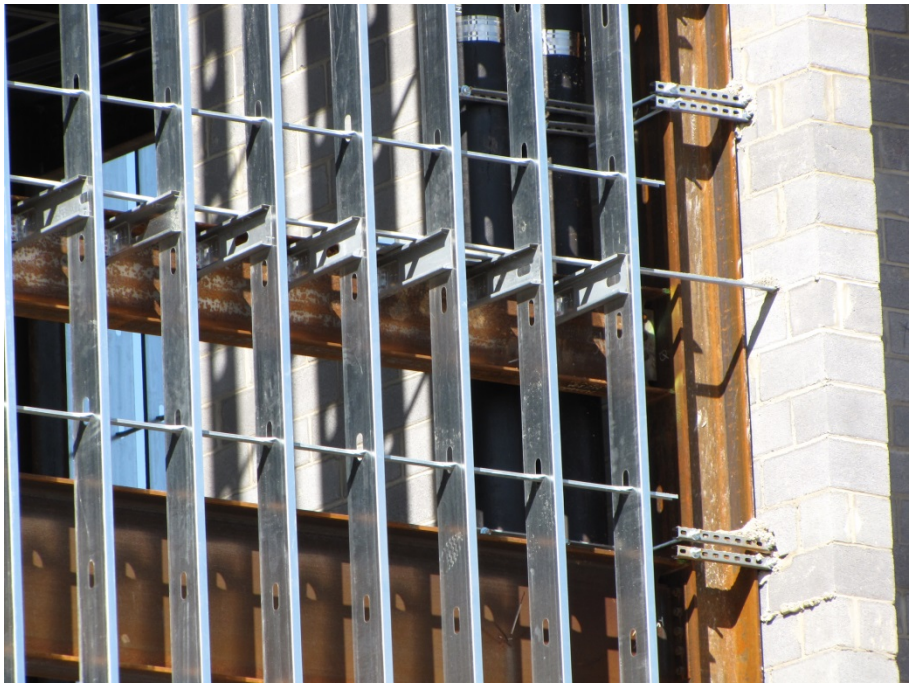

Figure 1. 3: One of the usage of cold-formed steel
Source: (Dinis *et al.*, 2012)

1.2 Problem Statement

Cold-formed steel structural member are widely produced with holes or opening such as joist, beam or column, purposely for piping, electrical-wiring, plumbing or bracing(Yap and Hancock, 2010). Basically it is manufactured with different shapes and sizes. Due to more complex and intense mechanical and electrical works in construction industry, large openings on the web is become more preferred by the contractors since it offer larger working area. Because of the variety of size and shape, a practical design need to be provide where the strength is theoretically reduced by the existence of

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